Research Paper

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Approach to Super Vision Robot by Using State Diagram and Vhdl Simulation

Engineering

KEYWORDS : DTMF, VHDL, Xilinx.

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ABSTRACT

In this paper author approaches to implement super vision robot based on DTMF technology, is controlled by cell-phone that makes a call to a cell-phone attached to the robot. ROBOT is any automatically operated machine that replaces human efforts. This paper proposes a control system which enables controlling remotely through mobile phone and DTMF (Dual Tone Multi Frequency). It is a generic communication term for touch tone. The keypad on the phone could be used to represent the digits and a separate tone is used for each digit. Pressing any key generate unique tone which consists of two different frequencies one each of higher and lower frequency range. The resultant tone is convolution of two frequencies associated with a particular key. Author tried to implement on her based with the help of Very High speed Hardware descriptive Language (VHDL) and state diagram represented by binary code and state levels, coordinated with frequency levels and controlling of the ROBOT. For simulation author used supporting tool preferred as ISE Xilinx.

Introduction

In this paper author tried to control a robot by cell-phone that makes a call to the cell-phone attached to the robot. In the course of a call, if any button is pressed a tone corresponding to the button pressed, is heard at the other end of the call is called dual-tone multiple/frequency (DTMF TONE) .The robot perceives this DTMF tone with the help of the phone stacked in the robot. The decoder decodes the DTMF tone into its equivalent binary digit and this binary number is send to the robot and programmed device to take a decision. For any given input and out-puts its decision to motor drives in order to drive the motor for forward , backward, left and right motion or to turn. The mobile that makes a call to the mobile phone stacked in the robot acts as a remote. So the simple robotic project does not require the construction of receiver and transmitter units.

DTMF signalling is used for telephone signalling over a line in the voice-frequency band to a call switching centre. The version of DTMF used for telephone tones dialling is known as 'touch-tone'. DTMF assigns specific frequency to each key so that it can easily be identified by the electronic circuit. The signal generated by the DTMF encoder is a direct algebraic summation, in real time of the amplitudes of two sine(cosine) waves of different frequency ,i.e. pressing '5' will send a tone made by adding 1336 Hz and 770 Hz to the other end of the line. Although the appearance and capabilities of the robots share features of a mechanical and movable structure under some control. The control of the robot involves three distinct phases: perception, processing and action. Generally, the preceptors are sensors mounted on the robot, processing is done by the processor, and the task (action) is performed using motors or with some other actuators.

Basic Principles of DTMF

DTMF as stated, is the short form of "Dual-Tone Multi-Frequency" and it is a method of designating digits with tone-frequencies that will be transmitted via an analog communication channel or network like a telephone line. It was developed by Western Electric and introduced by AT&T in 1963. During its development, unique individual frequency filters were chosen carefully so that the tones could easily travel via the telephone lines (the maximum guaranteed bandwidth for a standard telephone line extends from around 300 Hz to 3.5 kHz). DTMF was not intended for data transfer, rather for control signals only. With a standard DTMF encoder/decoder, it is possible to signal at a rate of around 10 tones/signals per second. The DTMF keypad is laid out in a 4x4 matrix, with two frequencies (each row representing a low frequency and each column representing a high frequency) played simultaneously by a standard home phone/ fax or mobile phone. Each key on the telephone's keypad has a unique frequency assigned to it. Pressing a single key (such as '1') will send a sinusoidal tone for each of the two frequencies (697 Hz and 1209 Hz). The multiple tones are the reason for calling the system as multiple-frequency. This prevents the misinterpretation of the harmonics and hence, it is immune to noise. These tone are then decoded by the switching centre to determine which key was pressed. When any key is pressed on the DTMF keypad, the circuit plays the corresponding DTMF tone. The DTMF keypad is arranged such that each row will have its own unique tone frequency and also each column will have its own unique tone. Below is a representation of the typical DTMF keypad and the associated row/column frequencies. When any of the key like "1", "2", "*", "#" etc is pressed particular code is transmitted. This code is consist of two frequency among which one is higher frequency and second one is lower frequency

KEYPAD BUTTON	Lower Frequency	Higher Frequency
0	941	1209
1	697	1209
2	697	1336
3	697	1477
4	770	1209
5	770	1336
6	770	1477
7	852	1209
8	852	1336
9	852	1477
*	941	1209
#	941	1336
0	941	1477

Figure. 2 The combination of frequency for respected keys

It gives 4-bit digital output Q1, Q2, Q3, and Q4 according to the received keys. Following figure shows the equivalent digital output as per related working of keypad.

KEYPAD BUTTON	FREQUENCY GENERATION	Q4	Q3	Q2	Q1
0	2277	0	0	0	0
1	1906	0	0	0	1
3	2174	0	0	1	1
5	2106	0	1	0	1
7	2061	0	1	1	1
9	2329	1	0	0	1
2	2033	0	0	1	0
8	2188	1	0	0	0
4	1979	0	1	0	0
6	2247	0	1	1	0
*	2150	1	0	1	0
#	2418	1	0	1	1
0	2277	0	0	0	0

Figure 3 The frequency output for each key.

Each of these tones is composed of two pure sine waves of the low and high frequencies superimposed on each other. These two frequencies explicitly represent one of the digits on the telephone keypad. Thus generated signal can be expressed mathematically as follows:

$f(t) = A1 \sin(2\pi f1\, t) + A2 \sin(2\pi f2\, t)$ ------- (A)

Where A1, A2 are the amplitudes & f1, f2 are the frequencies of high & low frequency range. Properties of DTMF tone frequencies are:

- No frequency is an integer multiple of another
- The difference between any two frequencies does not equal any of the frequencies
- The sum of any two frequencies does not equal any of the frequencies.

Advantages Of DTMF Signals

- As DTMF signal consists of a sum of two frequencies one from lower group frequencies and other from higher group.
- Frequencies (mutually exclusive group), it is almost impossible to imitate DTMF signal by speech or music signals. This is very useful in avoiding the interference of speech and music signals.
- Frequencies which are used are having lowest attenuation and constant delay characteristics.
- DTMF signals do not have even order harmonics as seen in the speech signal.

Why Cellphone Is Used To Control Landrover:

In wireless control of a robot (land rover), most of the times RF circuits are used. But there are some drawbacks associated with the RF circuit.

- **ADVANTAGES OF CELLPHONE OVER RF CIRCUITS:**

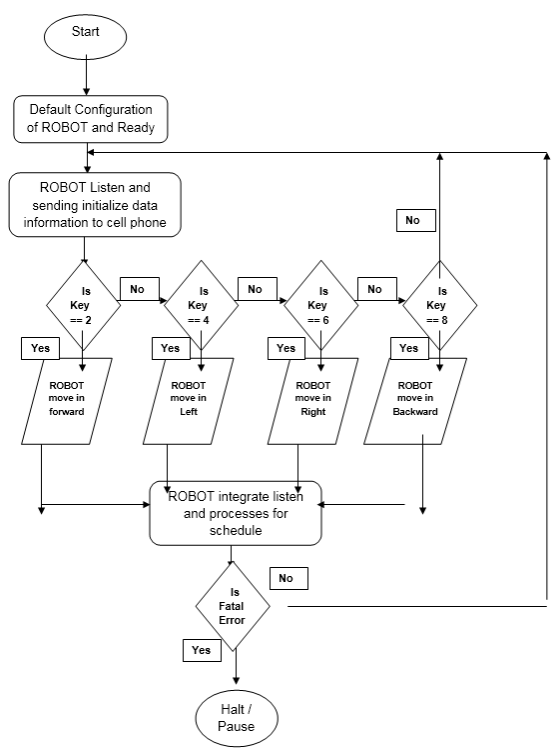
Cell-phone working range is as large as the coverage area of the service provider. Using touch-tone keypad of cell-phone, we can have twelve controls are available which can be used to serve different purposes. One of the significant advantages in using cell- phone is the use of a DTMF (DUAL TONE MULTFREQUENCY) signal as a carrier of different commands. If someone calls any person and press any button of touch-tone keypad when the call is being on, sound can be heard from the called Person cell-phone. This sound is nothing but a DTMF signal. So, one can use this signal to control some system at the called site. In order to control system, it is necessary to decode the signal and convert it to the proper format using signal conditioning circuit. Then conditioned signal can be used to process or to drive different hardware systems.

ARCHITECTURE AND FLOWCHART

Robots:- A Mechatronic Device is a degenerate robot with these special components: Sensors, which detect the state of the environment Actuators, which modify the state of the environment a Control System, which controls the actuators based on the environment as depicted by the sensors. A Robot is a mechatronic device which also includes resourcefulness or autonomy. A device with autonomy does its thing "on its own" without a human directly guiding it moment-by-moment. Some would contend that all mechatronic devices which operated on command of state machine. as per structural view of ROBOT operation the flowchart design in which the flow of operation of super vision . When we press keys in our cell Phone when call is in progress, these tones are based on the DTMF technology data is transmitted in terms of pair of tones. The receiver detects the valid frequency pair and gives the appropriate binary code as the output of the DTMF decoder. DTMF signal can be tapped directly from the microphone pin of cell phone device. The following table instruction will be use to control robot direction.

Table No. 1

Key	Direction
2	FORWARD
4	LEFT TURN
6	RIGHT TURN
8	BACKWARD



Flow chart of ROBO Operation

STATE

As per the flowchart try to implement in state as shown below, and what action taken by robot indicated in operation.

There are 11 states which are used for ROBOT operation.

1. **DEFAULT_CONFIG:- In this state ROBOT boot itself and default configuration of robot if key pressed by cell phone is**

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"1"

2. READY: - initialized core mechanism if key pressed by cell phone is "3"
3. ROBOT_ACTIVE:- robot ready for works in normal operation and time synchronisation if key pressed by cell phone is "5"
4. ROBOT_LISTEN:- transmission of robot wakeup pattern and data information to cell phone if key pressed by cell phone is "7"
5. ROBOT_SEND:- communicated with cell phone about data information if key pressed by cell phone is "9"
6. MOVE_FORWARD:- ROBOT move in forward direction if key pressed by cell phone is "2"
7. MOVE_BACKWARD:- ROBOT move in back direction if key pressed by cell phone is "8"
8. MOVE_LEFT:- ROBOT move in left direction if key pressed by cell phone is "4"
9. MOVE_RIGHT:- ROBOT move in right direction if key pressed by cell phone is "6"
10. INITILIZE_LISTEN:- When key pressed by cell phone is "*" then robot captures the data information and stored it in memory device
11. INITILIZE_SCHEDULE:- When key pressed by cell phone is "#" then robot sends all data information to controller cell phone for destination. It also send saved data information which stored by robot itself. It also send video and photo clip to the destination in frame structure format with the help of CODEC.

KEYPAD BUTTON	FREQUENCY GENERATION	Q4	Q3	Q2	Q1	STATE	OPERATION	MODULE BLOCK
0	2277	0	0	0	0	HALT	STOP ALL THE OPERATION / FATAL ERROR	ALL
1	1906	0	0	0	1	DEFAULT_CONFIG	DEFAULT CONFIGURATION OF ROBOT	ALL
3	2174	0	0	1	1	READY	INITIALIZE CORE MECHANISM	ALL
5	2106	0	1	0	1	ROBOT_ACTIVE	ROBOT WORKS IN NORMAL OPERATION & TIME SYN.	SENSOR,CODEC
7	2061	0	1	1	1	ROBOT_LISTEN	TRANSMITION OF THE WAKEUP PATTERN	SENSOR,CODEC
9	2329	1	0	0	1	ROBOT_SEND	TX THE WAKEUP PATTERN ON THE CONFIGURED	SENSOR,CODEC
2	2033	0	0	1	0	MOVE_FORWARD	ROBOT MOVE IN FORWARD DIRECTION	CAMERA, M1,M2
8	2188	1	0	0	0	MOVE_BACKWARD	ROBOT MOVE IN BACKWARD DIRECTION	CAMERA, M1,M2
4	1979	0	1	0	0	MOVE_LEFT	ROBOT MOVE IN LEFT DIRECTION	CAMERA, M1,M2
6	2247	0	1	1	0	MOVE_RIGHT	ROBOT MOVE IN RIGHT DIRECTION	CAMERA, M1,M2
*	2150	1	0	1	0	INTEGRATION_LISTEN	DETECTION AND STARTUP DATA TRANSMITTING	CODEC,FIS
#	2418	1	0	1	1	INITIALIZE_SCHEDULE	STARTUP FRAME & DERIVES A SCHEDULE FROM ROBOT	CODEC,FES
0	2277	0	0	0	0	ROBOT_PAUSE	IF COLLISION SEND TO NORMAL_ACTIVE	ALL

All commands shown in state diagram 1 which is shown below.

As per flow and state diagram the robot works in present state and next stage with key pad number and equivalent binary number with relative frequency generated by the key tone. As shown in state diagram 2.

KEYPAD BUTTON	Lower Frequency	Higher Frequency	STATE	BINARY	PRESENT STATE	NEXT STATE		
0	941	1209	T0	00000	HALT	DEFAULT_CONFIG 0000		
1	697	1209	T1	00001	DEFAULT_CONFIG	READY 0011		
2	697	1336	T2	00010	MOVE_FORWARD	ROBOT_ACTIVE 0101	INTEGRATION_LISTEN 1010	INITIALIZE_SCHEDULE 1011
3	697	1477	T3	00011	READY	ROBOT_ACTIVE 0101	ROBOT_LISTEN 0111	ROBOT_SEND 1001
4	770	1209	T4	00100	MOVE_LEFT	ROBOT_ACTIVE 0101	INTEGRATION_LISTEN 1010	INITIALIZE_SCHEDULE 1011
5	770	1336	T5	00101	ROBOT_ACTIVE	ROBOT_LISTEN 0111		
6	770	1477	T6	00110	MOVE_RIGHT	ROBOT_ACTIVE 0101	INTEGRATION_LISTEN 1010	INITIALIZE_SCHEDULE 1011
7	852	1209	T7	00111	ROBOT_LISTEN	ROBOT_SEND 1001		
8	852	1336	T8	01000	MOVE_BACKWARD	ROBOT_ACTIVE 0101	INTEGRATION_LISTEN 1010	INITIALIZE_SCHEDULE 1011
9	852	1477	T9	01001	ROBOT_SEND	INTEGRATION_LISTEN 1010		
*	941	1209	T10	01010	INTEGRATION_LISTEN	INITIALIZE_SCHEDULE 1011		
#	941	1336	T11	01011	INITIALIZE_SCHEDULE	ROBOT_PAUSE 0000		
0	941	1477	T0	00000	ROBOT_PAUSE	HALT 0000		

FUTURE WORK:-

Author will also try to design and implement of frame structure with the help of above state machine, state diagram, dataflow and providing the connectivity with cell phone

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